White Paper
on
Chemistry Project Status

July 1996

Chemistry Project Status

Introduction

The purpose of this white paper is to provide supplemental information related to the EOS Chemistry Project Cooperative Agreement Notice (CAN) for government/industry co-op(s) which will assess the potential for MedSat configurations as they might apply to the Chemistry Project. Included is a brief synopsis of events which have transpired in the chemistry project over the past six months, the role and objectives of the co-ops in project planning, and source data for instruments/system/interface requirements.

Chem-1 Study

Overview

The Chem-1 Study was performed in early 1996 to determine if the Chemistry Mission cost could be reduced through the aggressive pursuit of new technology. As a management tool, a substantial cost reduction goal was set while maintaining full science and the current 2002 (or earlier) launch date. Using a design-to-cost approach, instrument developers were then challenged to reduce resource requirements (mass/power/volume). Through new technology incorporation (MLS), reduced aperture size (HIRDLS), and constraints placed on resources (TES) the instrument P.I.'s were able to significantly reduce mass, power, and volume resources.

Mission Alternatives

Utilizing the new/lite instruments several mission options were identified, developed, and rated using defined set of "science-focused" metrics. As a result the following configuration options were chosen by the "Chem-1 Study" for further evaluation as part of detailed two-month Chemistry Implementation Assessment.

Option 1	Flight A	Full Size Common Spacecraft	HIRDLS, ODUS, MLS, TES (w/ additional capability for Flights of Opportunity)
Option 2	Flight A	Full Size Common Spacecraft	HIRDLS, ODUS, MLS (w/ additional capability for Flights of Opportunity)
	Flight B	MedSat	TES
Option 3	Flight A	MedSat	TES, HIRDLS
	Flight B	MedSat	MLS, ODUS

Chemistry Implementation Assessment (CIA)

CIA Overview

The objectives of the Chemistry Implementation Assessment were to, in further detail, evaluate the three Chem-1 Study options (plus the current baseline) for comparison. Areas of evaluation included mission configuration, spacecraft procurement approach, schedule, cost, instrument risk, instrument performance, spacecraft/instrument function sharing, new ways of doing business, ground system effects, and launch vehicle drivers.

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Payload Panel Recommendations

At a meeting in May the payload panel accepted the aggressive pursuit of new technology incorporated into the new MLS design thus retaining its considerable mass/power reduction. However, the potential loss of science related to HIRDLS reduced aperture size was deemed unacceptable. The HIRDLS full aperture design was restored with limited reductions in mass/power. Another important management decision, made at the recommendation of the payload panel, was for the instrument developers to proceed on with instrument development based on current designs.

Evolution of Chemistry Options

During the CIA two additional options evolved from assessment of the three Chem-1 Study Options. One option provided a shortened "Common-Lite" spacecraft sized for TES/HIRDLS/ODUS resources (and a smaller launch vehicle) and a subsequent MedSat development tied to the higher risk new technology MLS. The second option, driven by the desire for even smaller spacecraft, placed individual instruments on three smaller, but still MedSat sized spacecraft. The two options added during the implementation assessment are detailed below.

Option 4	Flight A	Common-Lite Spacecraft	TES, HIRDLS, ODUS
	Flight B	MedSat	MLS

Option 5	Flight A	MedSat	TES
	Flight B	MedSat	HIRDLS/ODUS
	Flight C	MedSat	MLS

Industry Survey - A Spacecraft Capability/Cost Comparison

During the CIA a quick-response industry survey was performed to assess the availability, applicability, and cost of commercial satellite busses in the 500 kg/500W class (instrument payload) which either had flown or were in the late design stage. A core set of Chemistry requirements for major subsystems were used to assess spacecraft applicability. With subsystem augmentation, ten commercial spacecraft were costed for management review.

Options Selected for Further Analysis

Management review of the CIA options and spacecraft under consideration resulted in a management commitment to proceed with instrument development. The Chemistry spacecraft baseline remained the EOS Common, but GSFC committed to further study two spacecraft configuration options. The two options selected for further assessment are detailed below.

Option 4a	Flight A	Full Size Common Spacecraft	TES, HIRDLS, ODUS, and FOO (Solstice/IMAS/ACRIM)	12/01 LRD
	Flight B	MedSat	MLS	6/02 LRD

Option 5	Flight A	MedSat	TES	9/01 LRD
	Flight B	MedSat	HIRDLS/ODUS	3/02 LRD
	Flight C	MedSat	MLS	12/02 LRD

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Low Cost Earth Satellite Study

In order for the Chemistry Project to examine alternative spacecraft configurations, a better understanding of the capability and cost of MedSats is needed. The method chosen to achieve that goal is a cooperative agreement between the Chemistry Project and industry to examine the development of Low Cost Earth Satellites.

Co-op Objectives

The focus of the co-op is to gain a better understanding of the capability and cost for the development of MedSats for earth observing missions using the Chemistry instruments as pathfinders. The major objectives of the assessment will be centered on:

- Development of a system concept which dramatically reduces the cost of satellites which meet the exacting performance requirements of EOS scientific instruments
- Breakpoints in the cost vs. performance trade space
- Projected life cycle costs from design through on-orbit initialization
- Methods for reduction of mission operations costs
- The feasibility of a $30M per mission cost (excluding instrument, launch vehicle, and operations costs)

Current Instrument Baseline

The current baseline instrument resource requirements for TES, HIRDLS (full aperture), MLS, and ODUS, used for this co-op assessment, are included as Table 1.

MedSat Configurations

If Chemistry were to be reconfigured, each option would include at least one MedSat. The MedSat configuration data is applicable to both options 4 and 5 for the MLS MedSat and for option 5 for the TES and HIRDLS/ODUS MedSats. Examples of MedSat concepts developed during the Chemistry Implementation Assessment are shown in Figure 1.

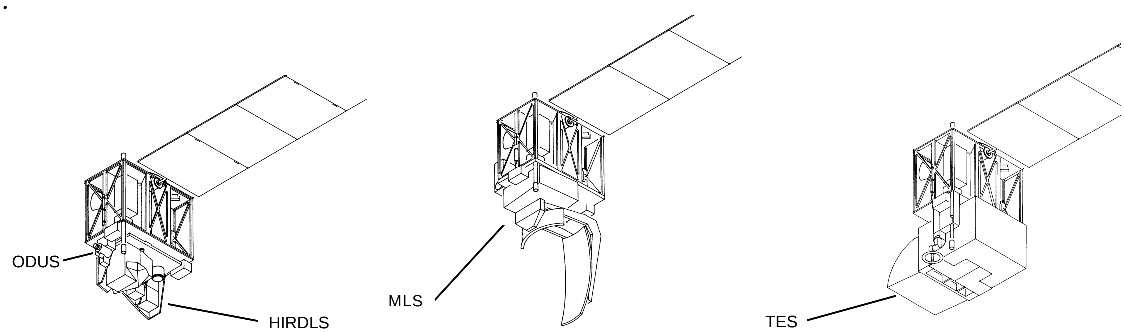

Figure 1. MedSat "MIDEX style" examples

MedSat System/Interface Requirements

In order to further define the co-op assessment, a compendium of system requirements, instrument descriptions, and interface requirements will be assembled and released in late summer 1996. Instrument solid models are available by anonymous ftp at kiwi.gsfc.nasa.gov in directory /pub/eos-chem.

Table 1 - Instrument Resource Requirements (Baseline, 6/25/96)

Instrument	Mass (kg)		Power (W)				Data Rate (kbps)		Data Storage (GB)	Pointing (arcsec)				Dimensions (mm)			Mounting Surface (Normal)	Instrument FOV (Relative to Nadir)	Unobstr. Thermal FOV
	Act.	w/25%	Ave.	w/25%	Peak	w/25%	Average	Peak		Control	Knowledge	Stability	Jitter	L	W	H			
TES	250	313	250	313	TBD	TBD	4900	6200	28.9	108	108	36/sec	TBD	1100	1400	1000	Nadir	Track (+45º/ -71º) Cross (±45º)	TBD
HIRDLS	140	175	155	195	230	288	50	100	TBD	900/all axes	120 pitch 120 roll 180 yaw	(Note 1)	(Note 2)	1420	1190	1370	Nadir	Track (+22.1º/+27.3º) Cross (-21º /+43º)	(+Y) Face (±85º)
MLS (GHz Channel)	220	275	220	275	TBD	TBD	115	115	TBD	1800 pitch 180 roll 1800 yaw	(Note 3)	TBD	50/s p/r 1800/s y 0.1 to 30s	1700	1100	2600	Nadir	Track (+60º/ +72º) Cross(±30º) (neg.offset)	TBD
MLS (THz Channel)	30	38	100	125	TBD	TBD	5	5	TBD	1800 pitch 180 roll 1800 yaw	(Note 3)	TBD	50/s p/r 1800/s y 0.1 to 30s	600	600	200	Nadir	Track (+60º/ +70º) Cross (±0.1º)	TBD
MLS (Total)	250	313	320	400	TBD	TBD	120	120	TBD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ODUS	40	50	40	50	TBD	TBD	50	50	TBD	1800	900	TBD	TBD	500	400	300	Nadir	Track (±0.8º) Cross (±60º)	TBD

Note 1: Long term stability - 180 arcsec pitch/roll/yaw, short term stability - 60 arcsec pitch/roll/yaw, Rate - 30 arcsec/sec pitch/roll/yaw.
Note 2: Equivalent s/c angular accel. < 1.9 radian/sec^2 rms, equivalent s/c angular motion < 3.1 arcsec rms, equivalent s/c translational accel. < 0.19 g rms (Detail in HIRDLS EID)
Note 3: Pointing knowledge requirements (1 arcsec/sec pitch/roll, 10 arcsec/sec yaw) are achieved through instrument hardware (gyro/position encoder)
Note 4: 705km 98.2 degree inclination sun synchronous orbits for all spacecraft